

Mechanical Systems Competency 4.2

Competency 4.2 Mechanical systems personnel shall demonstrate a familiarity level knowledge of financial management practices and application of contractor resources to meet commitments to mechanical systems quality, safety, cost, and commitments.

1. Supporting Knowledge and Skills

- a. Describe the process for preparing cost estimates and budgets.
- b. Describe and contrast direct and indirect costs.
- c. Define and explain the relationship between the following terms:
 - Budgeted cost of work scheduled (BCWS)
 - Budgeted cost of work performed (BCWP)
 - Actual cost of work performed (ACWP)
 - Earned value (EV)
- d. Describe the types of Earned Value, and how they are measured.
- e. Describe the types of data required to forecast cost and schedule performance.
- f. Define the term “estimate at completion” (EAC).
- g. Discuss the importance of formal change control in relation to project management.

2. Self-Study Activities (Corresponding to the Intent of the Above Competency)

Below are two web sites containing many of the references you may need.

Web Sites		
Organization	Site Location	Notes
Department of Energy	http://wastenot.inel.gov/cted/stdguido.html	DOE Standards, Guides, and Orders
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Review DOE 5700.2D, *Cost Estimating, Analysis, and Standardization*.

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Review DOE N 4700.5, *Project Control System Guidelines*.

Review DOE O 130.2, *Budget Formulation*.

EXERCISE 4.2-A Referring to DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, define cost estimating.

EXERCISE 4.2-B DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, provides several different methods for preparing cost estimates. Referring to the Order, describe them.

EXERCISE 4.2-C What are the “four distinct phases” of formulation of the Department’s budget?

EXERCISE 4.2-D Describe and contrast direct and indirect costs.

Read DOE N 4700.5, *Project Control System Guidelines*, Attachment 2, Project Control System Guidelines.

Read DOE Order 4700.1, *Project Management System*, pages III-25 through III-39, Project Control; and pages III-85 through III-89, Attachment III-7, Cost and Schedule Control Systems Criteria.

NOTE: This Order will be phased out upon the incorporation of its contents into contracts or other agreements. It is presented here because its general content remains applicable.

Scan DOE O 430.1, *Life-Cycle Asset Management*, Section 6, Requirements.

EXERCISE 4.2-E Define budgeted cost of work scheduled (BCWS).

EXERCISE 4.2-F Define budgeted cost of work performed (BCWP).

EXERCISE 4.2-G Define actual cost of work performed (ACWP).

EXERCISE 4.2-H Define earned value (EV).

EXERCISE 4.2-I How are EV, BCWS, BCWP, and ACWP used in performance measurement?

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Read DOE N 4700.5, *Project Control System Guidelines*, Attachment 2, Project Control System Guidelines; and DOE Order 4700.1, *Project Management System*, pages III-25 through III-39, Project Control, and pages III-85 through III-89, Attachment III-7, Cost and Schedule Control Systems Criteria. (Note that this Order will be phased out upon the incorporation of its contents into contracts or other agreements. It is presented here because its general content remains applicable.)

Scan DOE O 430.1, *Life-Cycle Asset Management*, Section 6, Requirements.

EXERCISE 4.2-J Describe the types of EV data elements.

EXERCISE 4.2-K How are the types of earned value measured?

Review DOE N 4700.5, *Project Control System Guidelines*.

EXERCISE 4.2-L Describe the types of data required to forecast cost and schedule performance.

Read DOE N 4700.5, *Project Control System Guidelines*, Attachment 2, Project Control System Guidelines; and DOE Order 4700.1, *Project Management System*, pages III-25 through III-39, Project Control; and pages III-85 through III-89, Attachment III-7, Cost and Schedule Control Systems Criteria. (Note that this Order will be phased out upon the incorporation of its contents into contracts or other agreements. It is presented here because its general content remains applicable.)

Scan DOE O 430.1, *Life-Cycle Asset Management*, Section 6, Requirements.

EXERCISE 4.2-M Define estimate at completion (EAC).

EXERCISE 4.2-N What is the purpose of EAC?

EXERCISE 4.2-O How is EAC used in contractor performance analysis?

Read DOE N 4700.5, *Project Control System Guidelines*, Attachment 2, Project Control System Guidelines; and DOE Order 4700.1, *Project Management System*, pages II-49 through II-81, Guidance for Preparing a Project Plan; and pages III-1 through III-15, Project Control. This Order will be phased out upon the incorporation of its contents into contracts or other agreements. It is presented here because its general content remains applicable.

Scan DOE O 430.1, *Life-Cycle Asset Management*, Section 6, Requirements.

EXERCISE 4.2-P Referring to DOE N 4700.5, what are the primary objectives of formal project control?

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EXERCISE 4.2-Q Why is formal project control important?

3. Summary

DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, defines cost estimate as:

“ . . . a statement of costs estimated to be incurred in the conduct of an activity such as a program, or the acquisition of a project or system.” Budget is usually defined as a financial plan used to estimate the results of future operations.

The contractor decides the nature of the cost, either direct or indirect, and the decision is reviewed by the Contracting Officer and Chief Financial Officer for the contract, using government-prescribed guidelines. There is no absolute list of costs that belong in one group or another.

Performance measurement data analysis is a dual responsibility of the contractor and DOE. The contractor performs this function for internal management needs and for preparation of the external reports to DOE. Cost, schedule, and at-completion variances that exceed established thresholds require review and analysis to determine the cause, to evaluate options to resolve the situation, and to report actions to higher management. These variances are calculated using the project management tools: earned value (EV), budgeted cost of work scheduled (BCWS), budgeted cost of work performed (BCWP), actual cost of work performed (ACWP), and estimate at completion (EAC). The use of these reports and control tools assist DOE and the contractor in:

- Determining the current contract cost and schedule performance status
- Highlighting areas requiring more detailed focus and attention
- Identifying deviations and trends
- Forecasting, verifying, or questioning future work status

Forecasting cost and schedule performance are integral parts of completing the project management plan for any project of any size. Accurate estimates of performance will give the oversight person better standards with which to measure performance.

Project management is a management approach in which authority and responsibility for execution are vested in a single individual. This approach provides focus on the planning, organization, direction, and control of all activities within the project. The project management plan is the document that sets forth the plans, organization, and systems which those responsible for managing the project shall utilize.

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A cornerstone of DOE's project management policy is the concept of accountability at appropriate levels for project control and management. An essential element of accountability is overall project control of technical scope, cost, and schedule baselines. The three major categories in the Project Control System are Baseline Development, Project Performance, and Change Management.

4. Exercise Solutions

EXERCISE 4.2-A Referring to DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, define cost estimating.

ANSWER 4.2-A DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, defines cost estimate as: “. . . a statement of costs estimated to be incurred in the conduct of an activity such as a program, or the acquisition of a project or system.”

EXERCISE 4.2-B DOE Order 5700.2D, *Cost Estimating, Analysis, and Standardization*, provides several different methods for preparing cost estimates. Referring to the Order, describe them.

ANSWER 4.2-B

Cost Estimate Technique	Description
Bottoms-Up	“Generally, work statement and set of drawings or specifications are used to ‘takeoff’ material quantities required . . . in accomplishing a given operation or producing an equipment component. From these quantities, direct labor, equipment, and overhead costs are derived and added thereto.” (DOE Order 5700.2D, Attachment 1,1)
Specific Analogy	These use the known cost of an item used in a prior system to estimate the cost of a similar item in the new system. Adjustments are then made to account for recognized differences in the two systems (i.e., design, complexity of performance, etc.).
Parametric	This requires historical databases on similar systems and uses statistical analysis to find correlations between the cost drivers and other system parameters.
Cost Review and Update	Previous estimates of the same project are examined for internal logic, completeness of scope, etc.

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Cost Estimate Technique	Description
Trend Analysis	Actual costs of work performed are compared to the original projected costs and a contractor efficiency index is derived. The index is then used to predict the cost of work not yet completed.
Expert Opinion	Specialists are consulted reiteratively until a consensus cost estimate is established. This is used in the absence of other data or techniques.

EXERCISE 4.2-C What are the “four distinct phases” of formulation of the Department’s budget?

- ANSWER 4.2-C (1) Field Budget Process: The field budget process is the first phase of the Department's annual budget formulation process. It is the process through which Field Offices prepare and submit field budget data to Headquarters Elements for use in the corporate review budget process.
- (2) Corporate Review Budget (CRB) Process: The corporate review budget process is the second phase of the Department's annual budget formulation process. It is the process whereby Headquarters organizations use, among other budget-related information, field budget data and spring planning decisions to develop initial budget requests that are jointly and considered in the Department's internal budget review, resulting in CRB budget allowances.
- (3) Office of Management and Budget (OMB) Budget Review Process: The OMB budget review process is the third phase of the Department's annual budget formulation process. It is the principal mechanism for preparing the Department's annual budget submission to the OMB. The Department's OMB request is based on the Secretary's final budget allowances resulting from the CRB process.
- (4) Congressional Budget Review Process: The congressional budget review process is the final of the Department's annual budget formulation process. It is based on final Presidential funding and policy determinations resulting from the OMB budget review process.

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EXERCISE 4.2-D Describe and contrast direct and indirect costs.

ANSWER 4.2-D Direct costs are costs that can be specifically identified with a particular project or activity, including salaries, travel, equipment, and supplies directly benefiting the project or activity.

Indirect costs are costs incurred by an organization for common or joint objectives and which cannot be identified with a particular project or activity. Examples are utilities, computer processing, security, and administrative expenses. Indirect costs are often referred to as overhead or burdened expense.

EXERCISE 4.2-E Define budgeted cost of work scheduled (BCWS).

ANSWER 4.2-E The sum of budgets for all control accounts for work scheduled to be accomplished within a given time period. Also, the time-phased budget plan (baseline) which represents the contract work plan.

EXERCISE 4.2-F Define budgeted cost of work performed (BCWP).

ANSWER 4.2-F The planned value of work accomplished or the value of the work completed. Also known as earned value.

EXERCISE 4.2-G Define actual cost of work performed (ACWP).

ANSWER 4.2-G The cost incurred and recorded in the accounting system for accomplishing the work performed within a specified time period. Also, the direct and indirect costs applicable to the work that has been performed.

EXERCISE 4.2-H Define earned value (EV).

ANSWER 4.2-H Earned value is the value of completed work expressed in terms of the budget assigned to that work. With regard to cost and schedule control systems criteria, earned value is the budgeted cost of work performed.

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EXERCISE 4.2-I How are EV, BCWS, BCWP, and ACWP used in performance measurement?

ANSWER 4.2-I A comparison of BCWS and BCWP indicates whether more or less work was done than was scheduled to be done. The difference represents the schedule variance in monetary terms. Comparing BCWP with ACWP results in a cost variance that indicates whether the work that was actually performed cost more or less than it was planned to cost. Analyses of cost and schedule variances enable the contractor (and DOE) to identify problems, to determine reasons for deviations from plans, to take corrective actions, and to report the results.

EXERCISE 4.2-J Describe the types of earned value data elements.

ANSWER 4.2-J

EARNED VALUE		
Earned Value (EV) Data Elements	Acronym	EV Data Element Description
Budgeted Cost of Work Scheduled	BCWS	Work Planned
Budgeted Cost of Work Performed	BCWP	Work Accomplished (Earned Value)
Actual Cost of Work Performed	ACWP	Cost of Work Accomplished
Budgeted Cost at Completion	BAC	Work Authorized
Estimated Cost at Completion	EAC	Estimate of Final Contract Cost
Cost Variance (BCWP minus ACWP)	CV	Cost Difference
Schedule Variance (BCWP minus BCWS)	SV	Schedule Difference
At Completion Variance (BAC minus EAC)	ACV	Cost at Completion Difference

EXERCISE 4.2-K How are the types of earned value measured?

ANSWER 4.2-K They are compared to the budgeted cost for work scheduled to obtain an indication of schedule performance, and are compared to the actual cost of work performed to obtain cost performance.

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EXERCISE 4.2-L Describe the types of data required to forecast cost and schedule performance.

ANSWER 4.2-L Cost estimates are prepared using appropriate estimating methodologies that are integrated with the WBS, and the DOE cost structure as specified by DOE, for all contract work. All estimates are to be consistent with DOE 5700.2D and in accordance with FAR 15.804, "Cost and Price Data Analysis," as appropriate.

FORECAST COST PERFORMANCE		
	Type of Cost	Description
Cost Estimates	Total Estimated Costs	Costs including the land and land rights; engineering, design, and inspection costs; direct and indirect construction costs; and initial equipment necessary to put the plant or installation into operation.
	Total Project Costs	All generic research and development, operating, and plant and capital equipment costs specifically associated with a project. (Total Project cost is the sum of the total estimated cost plus all other costs identifiable to the project.)

Planning and scheduling is a process that is established and is in operation through the life of the project to identify programmatic, operational, legislative, institutional, and other requirements or constraints which may affect technical, cost, or schedule baselines and ensure that such baselines reflect such potential impacts. Schedules are developed integrating the WBS and cost estimate, and represent all work scope regardless of funding source. Activity logic is used to depict all work scope, constraints, and decision points, and estimated and assigned durations to activities that represent work accomplishments. The detail scheduled activities form the master- and intermediate-level schedules as required.

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EXERCISE 4.2-M Define estimate at completion (EAC).

ANSWER 4.2-M The actual cost incurred to date plus the estimated costs (direct and indirect) of all remaining work, including authorized work that has not been definitized.

EXERCISE 4.2-N What is the purpose of EAC?

ANSWER 4.2-N To determine overall project status and performance against the authorized budget.

EXERCISE 4.2-O How is EAC used in contractor performance analysis?

ANSWER 4.2-O Based on the contractor's performance to date and estimates of future conditions, an EAC is computed and compared to the total budgeted cost for work scheduled or the projected budget at completion. At the contract level, total budget is usually equal to the contract value; therefore, the difference between the budget at completion and the EAC forecasts a contract overrun or underrun.

EXERCISE 4.2-P Referring to DOE N 4700.5, what are the primary objectives of formal project control?

ANSWER 4.2-P (Any reasonable paraphrase of the following.)

- To assure cost, schedule, and scope baselines are clearly defined, documented, and approved in accordance with DOE policies and directives
- To assure baseline changes are defined, documented, and approved, and authority and responsibilities for such approval are delineated
- To provide assurance that decisions are made at the appropriate management level
- To enhance accountability and traceability in the DOE decision-making process

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EXERCISE 4.2-Q Why is formal project control important?

ANSWER 4.2-Q (Any reasonable paraphrase of the following.)

Establishment and maintenance of project baselines are essential to project control for statutory adherence, funds control, Congressional scope limitations, and timely completion. As such, changes to baselines must be carefully controlled to avoid loss of control and distortions in performance reporting.